Care and Improvement of the Farm Woods

U. S. DEPARTMENT OF AGRICULTURE
Farmers' Bulletin No. 1177

PROTECTION and proper cutting or "weeding" help the farm woods in the same way that they help field crops.

Trees grown so close together in stands that their tops are nearly in contact produce clear high-grade timber products.

Young trees should be coming up in the openings. Such trees should be encouraged by keeping out livestock and fire and by the use of proper cutting methods. Sometimes it is necessary to plant young trees.

In cutting timber inferior kinds of trees should be cut to a smaller diameter than the more valuable trees, and all defective trees should be removed in order to improve the quality of the farm woods.

Grass in the woods is a sign that the trees are not close enough together or that the woods are being mistreated. Pasturing and timber raising at the same time on the same area are mutually disadvantageous.

Timber is an important farm crop, helping to increase materially the total farm income.

Care and improvement of stands of timber pay the farmer well. When given a little help and guidance by protection and the right use of the ax and saw, nature responds quickly in stimulated growth and also in improvement in the quality and value of the product.

Washington, D. C.

Issued March 1916
Revised February 1939
Slightly revised July 1941

CARE AND IMPROVEMENT OF THE FARM WOODS

By C. R. TILLOTSON, *senior forester, Forest Service*

CONTENTS

INTRODUCTION

THE FARM WOODS frequently furnish an essential portion of the farm income. Providing proper conditions for the growth of the trees will pay the farmer well both in comfort and in cash. If properly cared for, the woods will furnish at all times a convenient supply of timber, fuel, fencing, and the like for home use and at intervals will yield valuable material for market. If neglected or abused, farm timber stands are sure to deteriorate and may eventually disappear altogether.

On farms which have no woods the owner will often find neglected corners or poor-soil slopes where planted trees would be a profitable investment. The most should be made of these, for there are times when wood is as urgently needed as the products of the kitchen garden. The aim of this bulletin is to point out methods of caring for and improving farm woods so as to make them contribute as much as possible to both the owner's convenience and his purse.

By far the greater number of farm timber stands are in need of improvement. Poorer species are in the majority and are crowding out the better ones, many of the trees are overmature, some show evidence of attack by insects or disease, some are dead, young trees are entirely lacking in the open places, and grazing is often allowed to the extent of damaging the older trees and preventing reproduction. Improvement of these conditions may be secured through judicious use of the ax, by assisting natural reproduction, by the general exclusion of livestock from the woods, and, where necessary, through planting small trees, acorns, or nuts.

TYPES OF WOODS

There are two general types of farm woods, each of which requires a different method of handling: (1) Those characterized by the presence of old trees which dominate the stand, and (2) those made up of a nearly even-aged stand of second-growth trees.

Where old trees dominate the stand they may almost totally exclude the younger growth, or they may exist only as a few scattered individuals throughout the stand. Such timber is very likely to be deteriorating in quality. The problem is gradually to remove it, at the same time provide for a new stand of seedlings, and keep the stand of timber growing at a good rate. From the standpoint of sound business management, mature trees should be cut just as ripe wheat or oats are cut. The cutting of such trees usually is also desirable for the good of the remaining stand. Dead or diseased timber should not be allowed to stand. The first operation necessary, then, in woods of this type is to cut out at once the dead and diseased material. The second is to cut the mature living trees as soon as sufficient reproduction is started in the openings and marketing conditions permit a satisfactory sale. Heavy stands composed almost wholly of mature trees should not be removed all at once but gradually, to provide for a recurring income over a period of years.

In woods where the stand of old trees is not dense and reproduction is already well started, the mature trees should be cut as soon as this can be done profitably. Unless removed, these mature trees will suppress and kill young trees otherwise which would eventually be very valuable.

Where the woods are made up of nearly even-aged stands of second-growth trees, undesirable species may predominate and may be crowding out the better ones, or the stand may be overcrowded or understocked and not reproducing. The improvement of such woods may be brought about by various cuttings known as improvement cuttings and also by practicing certain methods of regeneration, both discussed later.

Thus, as a rule the harvesting of timber on small tracts such as the average farmer's woodland is a gradual process. The general rule to be kept in mind is to cut selectively, lightly, and profitably, and thus keep the stand in perpetual production.

ESSENTIALS OF GOOD FARM WOODS

The timber crop, like any other, should be judged by its quantity and quality. The end sought, therefore, should be to secure a full stand of trees of high quality. Fortunately, the quality of timber is determined very largely by how close together the trees are. To be of high quality, timber must be, for a considerable part of its height, free from limbs which are the cause of knots; it must be tall; and it must not taper too much from the butt to the top of the last log. In a dense stand of timber there is much competition for sunlight among the individual trees, with the result that height growth is increased. Trees in crowded stands are usually taller than those in uncrowded stands of the same age. When the trees are crowded so that sunlight does not reach the lower branches, these branches soon die and become brittle; they then fall off or are broken off by the wind, snow, or other agencies. By this process trunks are formed which are free from limbs, and hence of high quality.

When trees are crowded, their diameters do not decrease rapidly from the butts to the tops. In uncrowded stands just the opposite is true; height growth is usually less; the lower branches continue to live, increase in size, and form large knots; and there is a much

greater taper in the trunks of the trees. It is evident, therefore, that in good stands the trees should be so crowded that the crown or top of each individual tree is nearly in contact with those of its nearest neighbors. A well-stocked stand of trees produces not only a larger number but also a greater proportion of high-quality trees than an uncrowded stand occupying an equal area. This is shown in figure 1. This fact is of vital importance because the price of logs of first quality is usually from one and one-half to two times as much as that paid for logs of poor quality. Likewise clear straight trees are necessary to make poles or piling.

DENSITY OR STOCKING

The number of trees desirable per acre varies greatly with the age and prevailing size of the trees, also with the purpose or the kind of products to be grown. Table 1 gives the approximate numbers of trees per acre desirable for average good stands. The figures are generally applicable for oak, hickory, elm and ash and shortleaf and loblolly pines, but are 15 to 20 percent too low for maple, basswood yellow birch, beech, and white and red pines.

TABLE 1.—*Desirable number of trees per acre* [1]

Diameter 4½ feet, breast high (inches)	Number of trees [2] when their diameters range from—				Number of trees [2] when all are of uniform diameter
	2 to 10 inches	2 to 14 inches	6 to 18 inches	10 to 24 inches	
2	400	300			2,000
4	180	130			900
6	105	75	75		510
8	65	45	45		320
10	50	30	30	30	235
12		25	25	20	170
14		20	20	16	130
16			15	12	100
18			12	11	85
20				9	75
22				8	65
24				7	55
Total	800	625	222	113	

[1] Data furnished by E. L. Sponsler, University of Michigan.
[2] Of the respective diameters indicated in the first column.

KINDS OR SPECIES OF TREES

From the standpoint of rate of growth and marketing, some species are preferable to others. Black walnut, white oak, and yellow poplar, for instance, are now of more value than black oak, sycamore, or beech. It is probably best, as a rule, to grow those species which will produce the largest amount of wood within a specified time rather than to attempt to grow the species most valuable at a particular time. This means that trees of the most rapid growth which are well adapted to the region and situation and not subject to serious insect or disease attacks should be left to build up the stand.

The comparative rates of diameter growth of the most important species for which data are available are about as shown in the tabulation on page 5.[1] For the rates of growth of individual species in different regions table 3 (p. 22) should be consulted.

[1] Based on measurements of natural forest stands except where marked with an asterisk (*), in which case the figures are based on growth in forest plantations.

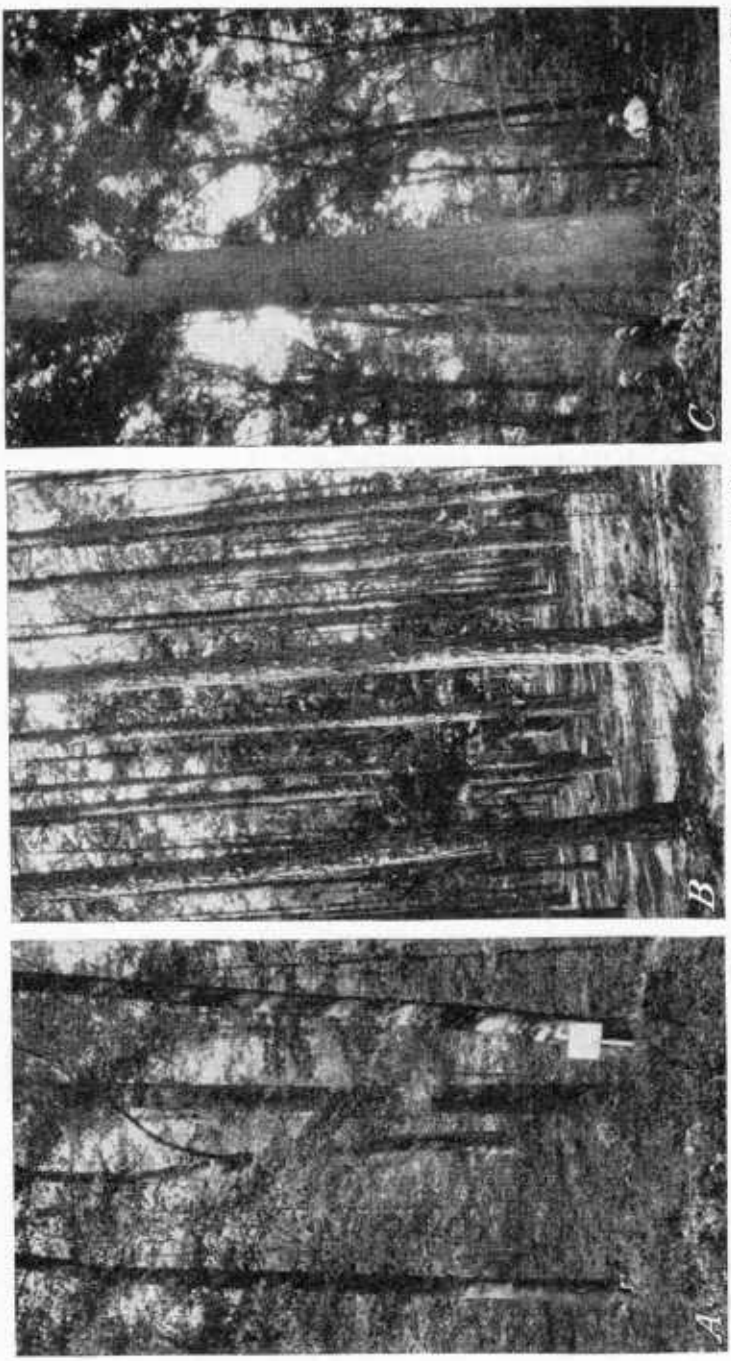


FIGURE 1.—Results of good timber management of farm woods: *A*, Valuable hardwoods; *B*, thrifty shortleaf pines evenly spaced by proper thinning; *C*, a timber-minded farmer, 64 years old, had made a good income all his life from his woods. For this white oak he had been offered as much as $250.

Average number of years required to grow 1 inch in diameter	Species
2 to 4	Cottonwood,* black willow,* white willow,* honey-locust,* black locust.
3 to 5	Shortleaf pine, bald cypress, slash pine, loblolly pine.
3 to 6	Red gum,* silver maple,* white elm, yellow poplar,* hardy catalpa.
4 to 7	White ash,* green ash,* boxelder,* black walnut,* white pine, red pine,* butternut, red oak, southern red oak, black oak,* bur oak, aspen,* Osage-orange, basswood.
5 to 10	Hickory, white oak, chestnut oak, paper birch, yellow birch,* hard maple, beech.
8 to 10	Red spruce (second growth).
9 to 18	Hemlock, balsam fir.
18 to 25	Northern white cedar.

The slower-growing species, particularly those listed in the last four lines of the tabulation, will not reach merchantable size as soon as the others, and from an investment standpoint should not be favored in the young growth, provided some of the more rapid-growing kinds will succeed. The value of these slow-growing species for farm purposes, however, will often make it equally desirable to encourage the growth of at least a few of them if the owner wishes material particularly fitted for his own farm uses.

IMPROVEMENT CUTTINGS

Any cutting designed to remove some of the trees in a stand for the benefit of the remainder is called an improvement cutting. When made in stands of seedlings or small saplings, such cuttings are for convenience designated as cleanings; when made in somewhat older stands, they are known as thinnings; when made in stands where scattered old trees are suppressing valuable young growth, they are known as liberation cuttings.

CLEANINGS

Often in young stands some of the less valuable species, such as chokecherry, black gum, and Virginia (or scrub) pine, threaten to overtop, crowd out, or damage the more valuable species such as white ash or yellow poplar; sprouts sometimes arise too thickly from the stumps of trees recently cut; or the reproduction of good species is too dense. In any of these cases some of the trees should be removed. Cleanings are nothing more than the weeding out of the poorer species or the poorer individuals where these interfere with the better ones. The practice of lopping the tops of the inferior species rather than cutting them off near the ground may be followed. The trees will then continue to live, force the growth of the better species, and still continue to shade the ground. Both to decrease costs and to avoid overcutting, only those inferior trees which are actually interfering with the better ones should be removed. The material cut out will usually be too small to pay for the expense involved. The justification for cutting lies in the bettering of the remaining stand.

THINNINGS

Young stands ordinarily reach a condition at ages of from 15 to 20 years which makes removal of some of the trees advisable. By means of thinning, the stand of trees that is to form the mature crop can be regulated and improved. The principle is the same as that applied by truck gardeners or orchardists who thin out their crops to secure the best development of a portion rather than a poor development of the whole. By crowding at the beginning, trees of high commercial quality are produced; but if crowding is allowed to continue after the lower branches die, it will cause stagnation both in diameter and height growth.

The presence of dead or dying trees in the stand, a dense interlocking of the tops or true canopy, stems very slender in proportion to their height, or an apparent stagnation in the height growth, indicate that a thinning is needed. Unless the condition of the stand makes earlier thinnings desirable, the best practice is to defer the first one until the product is merchantable and of sufficient size and value to pay for the operation. Thinning should be repeated as often thereafter as the wood growth has accumulated in sufficient quantity to pay for the cost. Often thinnings should be made every 5 years. Light thinning every 3 to 5 years is preferable to heavier thinning at longer intervals. The tendency always is to cut too heavily.

Fuel wood, pulpwood, and posts, will ordinarily be obtained from the first thinnings and larger-sized material from the later ones. In a small woods, thinnings may be made by the owner at odd times at no cost other than his own labor. When trees are cut for any use, care in their selection will pay in avoiding damage to the future stand.

As a rule the trees having the least prospective value should be removed (fig. 2). In any young stand the trees may be assigned to several classes according to the position of their tops or crowns—dominant, codominant, intermediate, suppressed, and dead. Dominant trees are the tallest ones, those whose tops receive almost complete sunlight; codominant trees are those of slightly less height that have relatively good tops which are not, however, fully exposed to sunlight; intermediate trees, which are in the process of being crowded out, are considerably smaller than those of the first two classes; suppressed trees are those that are hopelessly behind in height growth and will either be killed soon by the shade of the other trees or continue to exist only as stunted individuals. The trees which remain after a thinning should, as a rule, be those of the best form regardless of species, the most rapid growing, and, presumably, those of the highest final market value.

The trees to be removed should, accordingly, be the dead ones and those of the least-valuable and the slowest-growing species in the suppressed and the intermediate classes; but insect- and disease-infected specimens of all classes should by all means be taken out. To obtain a proper opening of the crown canopy, some of the dominant and codominant trees may also have to be cut.

In thinning, it must be remembered that the condition of the soil very much influences the health and vigor of the forest trees. The soil should be kept fresh, soft, loose, and free of a mat of grasses. With field crops this condition is attained by cultivation. In woods it must be secured by keeping the ground shaded and free from the

trampling of livestock. In making thinnings, therefore, it is desirable to retain any of the intermediate or suppressed trees which are necessary for shading the ground.

The extent to which the overhead crown canopy of a stand may be opened depends largely on the rate of growth of the trees and their demands for light. In general, openings should not be so large that they will not close again within from 3 to 5 years through the growth of the remaining treetops. In stands of rapid-growing trees, such as cottonwood, yellow poplar, red gum, loblolly, or slash pine, the crown canopy of the dominant class of trees can be opened to a greater extent than in stands of slower-growing species, such as white oak, ash, basswood, etc. Definite rules regarding the amount of material to be

E-11820 C

FIGURE 2.—Trees to be cut in improving the woods should be marked with paint or whitewash. The best time for marking is when the leaves are on; the best time to cut is usually in the winter. If the crooked, diseased, and slow-growing trees are removed, the growth rate and the cash value of the remaining trees will immediately begin to increase.

removed are not possible for all conditions, but generally not more than from one-fifth to one-fourth of the wood volume should be removed at a time (fig. 3).

The returns from thinnings will depend largely upon the market for the material removed. If the material is small and suitable only for a poor class of cordwood, it is quite likely that the product will not pay for the cost of the operation. It must be remembered, however, that the increased growth and value of the remaining product will usually fully offset this cost. The material taken out in thinnings may accordingly be considered as net gain. Where the market is good, thinnings have been made at a net profit of from 25 cents to $2 per cord. In one 8-acre woods of white pine in Connecticut thin-

325714°—41——2

nings netted the owner $44.32 per acre. When the thinning removes material suitable for posts, handle and hub stock, small piling, or ties, the operation undoubtedly will pay for itself. Pulpwood offers an excellent market for wood cut in improving the stand. The stumpage

NC-773 NC-883

FIGURE 3.—Well-managed farm woods in which the defective and less-valuable trees have been cut for fuel wood: *A*, Mixed hardwoods, including white and red oaks, hickories, and yellow or tulip poplar; *B*, 8 cords per acre have been cut, leaving 200 to 300 trees per acre to grow high-quality timber products.

returns vary all the way from 10 cents a cord for pine in some parts of the South to several dollars for spruce in New England.

LIBERATION CUTTINGS

Scattered old trees suppressing valuable young growth will often be found in woods that have been formed from seeding by adjoining trees of such an area as a worn-out pasture. The first trees to start

often have an abundance of room and consequently form very branchy stems and wide-spreading crowns. Such trees, commonly known as "wolf" trees, will never be of much value for lumber or poles, and their wide-spreading habit often results in suppressing and killing younger and better-formed seedlings or saplings which ultimately would be of considerable value if the conditions were more favorable. It is best in such cases to remove the old trees at once. A very similar condition is also found in woods which are the remnants of virgin stands. Scattered old virgin trees remain which, through shading, are hindering the growth of younger trees. Often these older trees, because they at one time grew in a dense stand, have a high commercial value. They should be removed as soon as a satisfactory sale can be arranged

F–219930, F–36975A

FIGURE 4.—Different kinds of improvement cuttings: *A*, Cut out rough, limby trees of poor form for quality timber; *B*, cut grapevines, except a few on low-grade trees, to be left for wildlife. This farmer let the grapevine kill this fine black walnut tree in his woods close by the home.

CUTTING OUT VINES

Grapevines, ivy, honeysuckle, and woodbine occur widely in the woods and often twine about the trunks and spread throughout the tops of the trees. They affect both conifers and hardwoods and do more damage than is commonly realized, as shown in figure 4. When they are large, their heavy foliage and small branches shade out and kill the leaves and thereby the trees. Also by their sheer weight they often bend over the tops of the trees, which are thus either killed or made unthrifty.

The vines themselves have no material value, and they should accordingly be eliminated by severing the main stem near the ground. It will be best to carry on this operation while the vines are small and

before they have done any appreciable damage; and, if lack of time prevents a thorough job, cut at least the larger ones which obviously are doing most harm. The food value to wildlife of fruit from different kinds of vines is something which should always be kept in mind. It is always well, therefore, to leave some vines on trees of little commercial value because of their importance in maintaining a full measure of beneficial or valuable population of birds, rodents, and mammals.

PASTURING FARM WOODS

Pasturing the woods has been one of the chief causes of their depletion and low earning power. The severity of the damage depends largely upon the number of stock and the size of the woods. One characteristic of a heavily pastured woods is the almost complete absence of young growth, or its existence only in small ragged patches as broken or scrubby stuff. Cattle, horses, sheep, or goats eat young seedlings, particularly the hardwoods, trample them out, or brush against them and break them off. Hogs eat the seed and thus prevent reproduction from starting, or root young seedlings out of the ground, and sometimes eat the roots (figs. 5 and 6).

In those parts of the southern longleaf pine region where hogs run at will, they are known to do a great deal of damage to longleaf pine seedlings and often damage trees several feet in height. When driven out of the swamps by high water in the late winter and early spring, they root up the longleaf pine seedlings and eat the sponge bark on the roots. Observations first carried on at Urania, La., have shown stands of several thousand longleaf pine seedlings per acre on areas protected against hogs and no seedlings on adjacent areas which were unprotected. Generally the grazing of other livestock in the southern pines is not particularly harmful and may even be beneficial in reducing the fire hazard.

Tree growth is severely damaged through trampling and wounding the roots and through compacting the soil to such an extent that it is almost impervious to water. Horses sometimes peel the bark from trees. Old trees show the abuse in the dying of their tops, in a decrease in the amount of foliage, and often in the beginning of decay at the butts. A light cover of grass then makes its appearance and increases the drying of the soil.

When the crown canopy of a woods in unbroken and young growth is not desired, a few cattle may be grazed. They should not, however, be turned in when the ground is very soft—when the frost is going out, for instance, or during a rainy season. The soil is too easily compacted at that time. When it is desired to secure natural reproduction, hogs may be turned into the woods shortly before the seed is to fall. They will root up the ground and put it in good condition for the reception of the seed. Thereafter, however, they should be kept out.

Goats and sheep should be allowed in the woods only when it is desired to clear up brush of undesirable species, so as to make possible the reproduction of better ones. If the better species are already present in mixture with the poorer ones, some method of cutting, rather than grazing, should be followed to clear the area of the poorer species. Horses should at no time be permitted in the woods.

F—239099

FIGURE 5.—Woods in which cattle and hogs have run. There are no young trees to fill up the openings; the soil is packed tight, sheds rainfall quickly, and is very dry when trees need moisture in summer. Such pasture is hard on the cattle, for the shaded ground affords but little grass.

F—227104

FIGURE 6.—Woods protected from livestock are reproducing themselves by seeds and sprouts and growing rapidly because of the shade and moisture afforded by the natural, spongy ground cover of humus, litter, and young growth.

Stockmen are quite generally agreed that grass produced under the shade of timber is considerably less nutritious than the same species growing in full sunlight. It is also usually much more sparse. The actual value, then, of woodland pasture is small. Fifty cents to one dollar per acre per year is probably a liberal estimate of the value of woods forage. Thrifty, fully stocked stands of timber will grow at the rate of 250 or more board feet of lumber per acre or the equivalent in other products per year. Considering only this growth and assuming the value of the standing timber to be from $5 to $15 per 1,000 feet board measure, the value of the timber growth is from $1.25 to $3.75 per acre per year. Stumpage values are sometimes much higher than this, especially if there is considerable white oak, yellow poplar, walnut, or other valuable species in the stand. If the timber is given good care, moreover, the growth should be as much as 500 board feet

F-242996

FIGURE 7.—This farmer has good reason to be commended for his profitable practice of excluding all livestock from this woods and affording the animals plenty of shade in a sunlit pasture.

per acre per year. The greater value of the woods for growing timber, as compared with the value of its forage only, is apparent (fig. 7).

It must not be thought possible to secure this growth of timber and utilize the woods for pasture at the same time. Grass in the woods is almost an infallible indication that the woods are not fully stocked or are being mistreated. Grass will not thrive without strong sunlight, and in a woods in good condition sunlight reaches the forest floor only to a very limited extent. Pasturing and timber production cannot, therefore, be practiced on the same area except to their mutual disadvantage; and the combination of the two will not pay the owner as well as the practice of either one separately.

However, the value of shade to stock is sometimes very considerable as compared with the loss in timber growth because of pasturing. If, however, shade rather than forage is the chief value of the woods to stock, it can usually be provided by allowing the stock to range in

only a portion of the woodland. The remainder may more profitably be devoted to the production of wood alone.

FIRE PROTECTION

In the North, because farm woods exist for the most part as small, scattered bodies of timber, which are constantly under the owner's supervision, there need be very little damage from fires. In the South, where farm woodlands are often of considerable extent and where it is still the common practice of some people to burn the woods for various reasons, special precautions need to be taken to keep out fires.

It is commonly possible to plow several furrows around the woods, which will assist in stopping a fire. Perhaps a close watch during the fire season and vigorous measures to fight fire once started are the best that can be done at present. In addition, an endeavor can be made to arouse public sentiment against setting fire in the woods. Owners are increasingly concerned about fires in their woods, because they do realize that these may do great damage. Fire burns the fallen leaves and accumulated litter of several years, thus destroying the material with which trees enrich their own soil. The soil becomes exposed, evaporation is greater, and more of the rain and melted snow runs off the surface. The roots may also be exposed and burned. Conditions are such that the vitality of the trees is weakened and their rate of growth decreased. Fires often kill a great many of the young seedlings up to 1 inch in diameter. Although this young stuff is still often regarded as brush, it must be remembered that every large tree was in the brush stage once and that the brush of today will be the large timber trees of the future.

Very severe fires kill some of the larger trees and burn through the bark of others. These wounds lower the value of the butt log for lumber, and afford a ready point of entrance for rot-producing diseases, which often cause deterioration in the quality of the logs for a considerable distance above the wounds. By the entrance of rot the sale value of a tree may easily be decreased by from one-half to two-thirds. Rotten logs are seldom classed as No. 1, and usually as culls. Fires, then, may be expected to destroy the vegetable manure of the forest floor, to kill young growth, to weaken vitality and growth of older trees, and to lower the sale value of timber. Through the killing by fire of the young growth, which permits more light to reach the forest floor, the growth of grass is encouraged, and pasturing is probably made somewhat better, but is it believed that, everything considered, the burning of woods to improve the pasture does not pay.

The attitude of the landowner toward fire has much to do with what the neighbors, hunters, or other visitors do to prevent fire. It is possible to mold local public sentiment on the subject. A firebreak in the form of a strip of plowed furrows exposing fresh mineral soil around the timber or connecting roads or open fields often serves effectively in stopping ground fires, or as a break in backfiring if perchance the conditions should seem to warrant this hazardous practice. Such a firebreak is shown in figure 8. Tools for fighting fire include rakes, shovels, fire flappers, or swatters (rectangular pieces of old belting fastened to a small pole handle), and buckets. These should be kept readily available during fire seasons.

INSECTS AND DISEASES

Damage from either insects or disease is always possible. It is more likely to be serious with some species of trees than with others. Disease is likely to be worse in woods which have been damaged by fire, grazing, lumbering, wind, or any other agency which has served to break the bark or roots and expose the living inner tissues.

The damage done by a leaf-eating insect is apparent in the destruction of the foliage. When the insect is one that works under the bark and either bores into or girdles the tree, its presence is manifested by fine sawdustlike particles of wood which fall out of the burrows and collect either around the base of the tree or at the entrance of the burrows. Sap or gum also often exudes from these entrances. When the attack is serious, the leaves of hardwoods change to their autumnal color, while those of conifers become brown or red. The bark of

F- 208226

FIGURE 8.—A plowed strip several furrows in width forms a firebreak for slow ground fires and for backfiring if conditions warrant such hazardous action.

trees killed by girdling insects becomes loose; and on its inner surface, as well as on the surface of the wood of the tree, there will be found more or less numerous regular wavy passages, or so-called galleries. These are formed by the grubs as they eat their way under the bark. The wood is their food during the course of their development.

The presence of wood-rotting disease is indicated by hollow stems, discoloration and rot of the wood, and by fruiting bodies. These are the mushroom- or bracket-shaped bodies which appear somewhere on the trunk, branches, or roots of the tree, most often at some point where the tree has been wounded. Other types of disease which may seriously damage trees but do not rot the wood may have rather inconspicuous fruiting bodies but are manifested by an unhealthy appearance of the tree, dying of the branches, distorted twigs or branches, sunken places in the bark, and possibly other indications.

Full information regarding the damage from either of these sources and the methods of control may usually be secured either from State experiment stations or the United States Department of Agriculture, Washington, D. C.

CARE IN LOGGING

When the timber in the woods is being cut, steps can be taken toward insuring the perpetuation of the woods and at the same time improving the quality of the stand. Lumbering operations which remove only trees of high quality, such as white oak or black walnut, and leave dead, dying, insect-attacked or diseased specimens and inferior trees should not be practiced. The diseased and dying trees will be a menace to the remaining healthy ones, and the beech, black gum, ironwood, Virginia scrub pine, and other inferior species which remain will scatter their seed over the ground, and very largely make up the future stand. In cutting, therefore, or in selling the standing timber, provision should always be made for these inferior species to be taken down to a smaller diameter than the more valuable ones and for all defective trees to be removed. To make such a provision effective, the owner should mark in some manner all the trees which he desires cut or all those which he wishes to retain in his woods. To induce the lumberman to take inferior species and small and defective trees, it may be necessary to make some concessions in regard to price. The trees which remain will be the nucleus of the future crop, and valuable species should be in the majority in sufficient quantities to seed the cut-over areas.

Unless small, straight, and vigorous trees bring higher prices per unit of measure than large ones or unless they are of species which it is desirable to eliminate, they should not be cut by the woods' owner, nor should he allow lumbermen to cut them. As trees 10 inches and less in diameter cut only very small amounts of low-grade lumber, they are of little value. Ordinarily, if they are to be sawed into lumber, the lumberman figures on paying little or nothing for them. He cannot afford to do otherwise. Trees of such sizes, however, are usually growing rapidly or will do so when the other trees are removed and they receive more sunlight. As they increase in size, they will cut not only more but also higher-grade lumber; they will, accordingly, increase faster in value than in size. It is therefore apparent that they should not be cut.

In felling trees care should be taken not to throw them into the midst of a group of young trees; otherwise these may be seriously broken or bent. Further, by the exercise of a little care when the logs are being dragged out of the woods, much breakage, bending, and trampling of the young growth can be avoided. It must be kept in mind at all times that these young trees are the first stage in the growth of the mature timber. Every care should be taken to prevent their destruction, particularly those of the better species, because such young trees represent an established growth several years old. A new stand of seedlings may not only be difficult to obtain, but it will not have the advantage of these several years of growth. When standing timber is sold, the lumberman should be charged with protecting this young material as fully as possible.

When cutting for his own use, the owner should, so far as possible, observe rules similar to those outlined for lumbering operations. Dead and defective trees can often be used for fuel wood and pulpwood, respectively; the poorer species may sometimes serve nearly as well as the better ones for a special farm need; damage to young growth can be avoided; and the operations can be carried on at such a season of the year and in such a manner as will aid effective sprout reproduction.

PERPETUATING THE STAND

A very striking condition in the greater number of farm woods is the absence of small trees. In woods that are fully stocked with even-aged trees of about the same size, small trees need not be expected, nor should their growth be encouraged. Where, however, as is more commonly the case, the woods are made up partly of mature and partly of decadent trees that should be cut and whose crowns do not fully shade the ground, young trees should be coming up in the openings. Under normal conditions, these young trees would be present, but because of pasturing and fires often they do not start. Grass and weeds appear instead; and, if pasturing and fires continue, conditions become such that, without aid, there is little possibility of securing a natural growth of young trees.

NATURAL RESTOCKING BY SEED

If the woods have not been too badly abused and there is no heavy sod of grass present, excluding stock and fires will in time normally result in the site's restocking itself by natural seeding. Good seed years, however, come only at intervals. Even in a good seed year, the seedlings may not be able to get a start because of the sod, the packed condition of the soil, or unfavorable weather. Natural reproduction may, therefore, be very slow, becoming satisfactory in amount only after from 5 to 10 years. It will often be advisable, therefore, when there is a good crop of seed on the trees, to put the ground in such shape as to insure a good crop of seedlings. Before the seed is scattered from the trees in the autumn, the ground may be disk-harrowed or cultivated, or hogs may be turned in to root up the soil. The seed will then lodge in the soft earth, where, upon sprouting, the roots may easily take hold. To prevent undesirable species from obtaining a foothold, any trees of such species large enough to bear seed should be cut at the time pasturing is discontinued.

To secure natural reproduction an old, mature, dense stand will normally have to be opened up in two, three, or more cuttings, each taking one-third to one-half or less of the trees. The first cutting is designed to open up the crown cover somewhat, so that the leaves on the forest floor may decompose more rapidly, the mineral soil become exposed, and the germination of seed be more certain. The remaining trees become more wind-firm, and, as a result of their crowns receiving more sunlight, they produce more seed. When the forest floor is in good condition, the later cuttings may be made during winters following heavy seed crops. With the removal of these trees the conditions will be favorable for the germination of the seed and the growth of the seedlings. Neither of the first two cuttings should be so heavy that enough light will reach the ground to encourage a heavy growth of weeds or grass. The later cuttings should be made

after the seedlings are well established and no longer in need of the protection of the old trees.

REGENERATION BY SPROUTS

It is not always possible to secure a new growth through sprouts from the stumps of felled trees. Most conifers do not sprout effectively, and the majority of hardwoods do not sprout vigorously beyond the age of 60 years. Basswood is an exception, for it can be depended on to sprout well from healthy stumps up to an age of 100 years. Vigorous individual trees of other species may also often do likewise. Sprout regeneration, then, is especially applicable to hardwood stands which are to be cut when young, as, for instance, stands which are to be cut over every 20 to 30 years for posts or fuel. It should be remembered that sprouting is most vigorous from low stumps. It is also better from the stumps of trees cut during the winter or very early spring. Such sprouts, moreover, are less subject to severe winter injury at the end of their first season's growth than are those arising after timber is felled during the summer.

In felling the trees, care should be taken to injure the stumps no more than can be helped, as the best sprouts will ordinarily arise from good, clean stumps. Because of the clean cut which it makes, the ax is a better tool than the saw in felling trees where regeneration by sprouts is desired. Regardless of what tool is used, the surface of the stumps should be slanting, so that water will not collect and promote rot.

PLANTING TREES OR SOWING SEED

Some woods are so run down that very little seed is produced and natural reproduction cannot be secured even if the area is disked or harrowed, or at least cannot be secured rapidly enough to be satisfactory. Often it is desirable to grow species different from those present or to grow a greater proportion of one species than of another. Sometimes no woods exist at all, but one is desired. In these cases planting or sowing is necessary. The planting of small trees is by far the more successful and economical method. Nut trees, such as oaks, hickories, and walnut, are the chief kinds started by direct seeding.

Where it is desired to establish a timber stand by planting or sowing, the area to be selected for the purpose merits some attention. A large percentage of the farmers in the unwooded Plains region have planted woods around their buildings and feed lots, primarily for protective purposes. Although the trees usually have been planted on very good agricultural soils, these men have considered tree production justified even though the wood produced might not equal in value the agricultural crops which might be grown on the same land. The monetary value of the protection to livestock and the saving which it has meant in winter fuel in the home, is difficult to estimate. Determinations have been made, however, regarding the effect of trees as windbreaks on the wind velocity and on crops protected by them from the prevailing summer winds. It has been found in the prairie region that through the protection afforded by the most efficient grove windbreaks, the yield in farm crops is increased to the extent of the crop that could be grown on a strip three times as wide as the height of the trees.

Where protection is not considered essential, the logical places for establishing a woods are on those portions of the farm which have steep slopes, or soil so rocky, sandy, or wet that the returns from agricultural crops are meager. Steep hillsides in particular are likely to erode; and even though returns can be secured for a few years after clearing from growing agricultural crops on them, they are likely soon to become so eroded as to be practically useless for crops. Such lands can be more profitably devoted to pasturage or the growing of timber, as shown in figure 9. Lowlands which are not satisfactory for the growing of farm crops will produce excellent stands of some species of timber within their natural range, such as cottonwood, cypress, red gum, swamp white oak, and other trees of a moisture-loving kind.

SPECIES

The species of trees to be given preference in planting reforestation operations should be those which are native to the region and which are of the most rapid growth. Red and white pines and Norway spruce lead in quantity planted in the Northern States, and shortleaf, loblolly, and slash pines in the South. Though some of the most rapid-growing trees shown in the tabulation (pp. 22–25) are not at present so valuable commercially as the most slow-growing ones, their values are increasing, and future increase will probably be proportionately greater than that of the others.

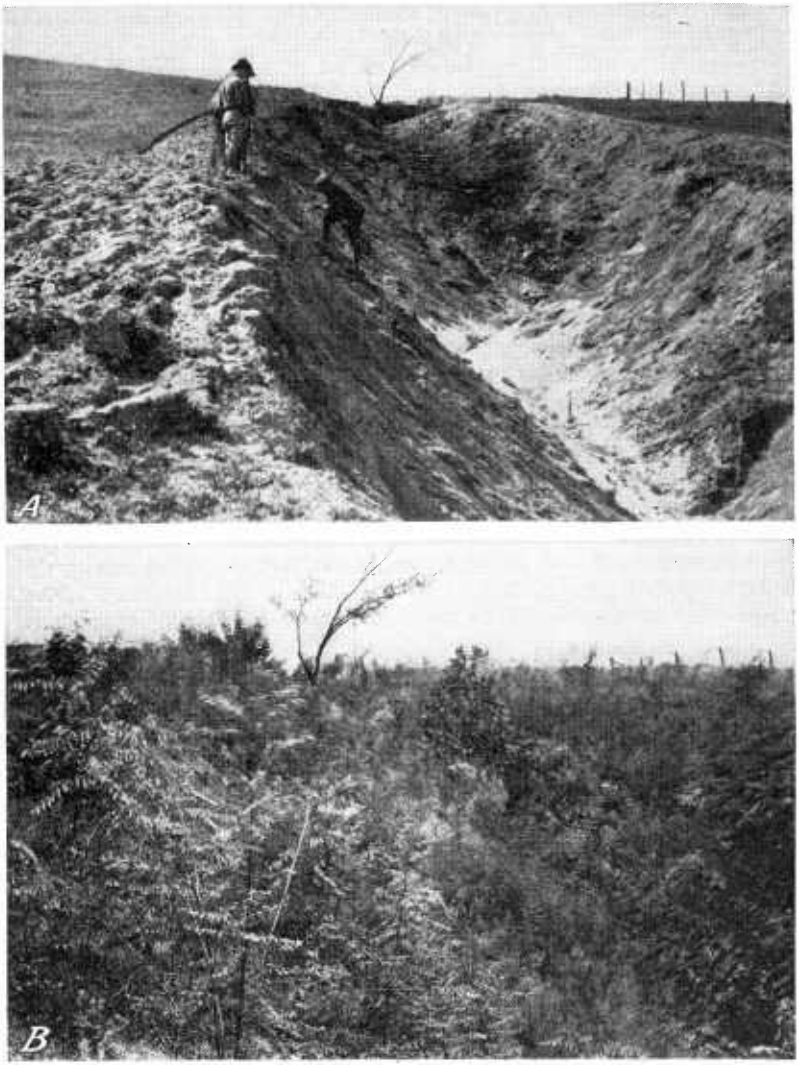
SPACINGS

The proper spacing to give in planting trees depends largely on the form or habit of the species and the character of the situation or site. In general, the more tolerant the trees are of shade and the more unfavorable the situation, the closer should be the spacing. Very close spacing reduces the number and the size of the branches, which means that the trees will be of higher lumber value. It means, however, a greater death rate among them because of competition, and a higher initial cost of planting because of the greater number of trees required per given area.

On the unfavorable sites, close spacing is best. The same is true even on the better sites when cultivation cannot be practiced for the first 2 or 3 years. The greater number of trees per acre offsets the higher mortality when first set out, and it results in better protection of the soil because of the greater amount of shade furnished.

Species that are tolerant, that is, species that will grow well under shade, such as sugar maple, beech, spruce, shortleaf pine, and hickory, can be spaced more thickly than those that are not tolerant, such as cottonwood, red, loblolly and slash pines, and black walnut. The best results will ordinarily be secured by planting a mixture of species, such as cottonwood and soft maple, black walnut and sugar maple, red oak or white oak, yellow poplar and sugar maple or white ash, white and red pines, or shortleaf and loblolly pines. Black locust is a good tree to mix with other hardwoods as it feeds them nitrogen, but it grows fast and should be planted 1 to 3 years afterward. In these cases the cottonwood and yellow poplar would be spaced 8 to 12 feet apart and black walnut 30 or 40 feet apart, and the maples, oaks, white ash, or black locust would be planted between them. Such a combination induces rapid height growth of the first-named kinds of trees and causes them to shed their lower branches early in

life; and because of the ability of the other species of trees to live under the shade of the cottonwood, black walnut, and poplar, the ground is kept well-shaded and in good condition. It being kept in mind that



F-288026 F-310017

FIGURE 9.—The soil on this farm-land slope is deep and rich and devoted to field crops. However, serious gullying is going on in places. The most practical treatment is to check the erosion and restore the land to timber production: *A*, The banks sloped and ready for planting small tree seedlings; *B*, a year later, the gully slopes are fixed by a mass of vegetation including black locust and black walnut trees, lespedeza, and native herbaceous growth.

where wide spacings are followed it is desirable to fill in between with more slowly growing but tolerant trees; spacings about as indicated in table 2 should be given when the trees are to be grown to an age of 40 years or more. It is not intended to thin the stand at an earlier age

TABLE 2.—*Spacing to be followed in forest plantation*

Trees required per acre when spaced—				
12 by 12 feet	8 by 8 feet	6 by 6 feet	5 by 5 feet	4 by 5 feet
Number 303	*Number* 680	*Number* 1,210	*Number* 1,743	*Number* 2,178
Cottonwood (black walnut, 30 or 40 feet apart).	Yellow poplar, red gum, slash pine, white ash.	White pine, red pine, loblolly pine, shortleaf pine, red oak, black oak, black locust, southern cypress.	Hickory, white oak, chestnut oak, bur oak, post oak, red elm, basswood.	Sugar maple, yellow birch, beech, white spruce, red spruce, fir.

The species in the last two columns of table 2 will withstand considerable shade without being killed, and accordingly are the ones that may most safely be used in planting midway between such trees as are shown in the first three columns.

If seed is to be sown or planted rather than trees planted, the quantity to be used per acre depends upon a number of considerations, such as the quality of the seed, the amount of preparation given the soil, the danger of destruction of the seed by squirrels, mice, birds, etc., its price, the rate of growth of the seedlings, and their sensitiveness to frost, drought, and other such damage. The uncertainty of successful results from broadcasting seed, even when the soil is prepared, makes it advisable to confine direct-seeding efforts to prepared and protected spots.

When the seeds are placed in prepared spots evenly spaced over the area, two such seeds as walnuts, hickory nuts, or acorns should be placed in each spot and about 10 of any of the other species. This is simply to guard against failure of the seed to sprout, its destruction by rodents, or the death of some of the seedlings after sprouting.

STOCK

In general there is far more certainty of success from planting trees grown in a nursery than from sowing seed directly on the permanent site. The nut-bearing trees, however—walnuts, oaks, and hickories—develop during their first year a deep taproot with very few laterals. This rather unfits them for growing in a nursery and later removing them to the field. The most practicable method with these species is to sow the nuts directly in cultivated spots in the field. Fall sowing is usually preferable to spring sowing unless there is danger of the nuts being disturbed by rats, squirrels, or hogs.

One-year-old hardwood seedlings and 1- or 2-year-old nursery-grown coniferous seedlings or transplants are the best classes of stock for planting. They are not so large as to be unduly expensive, and ordinarily small stock is more likely to succeed than large. Transplanted stock of coniferous species usually has a better root and is sturdier than seedling stock. Accordingly it is more suited for planting on inhospitable sites and on all sites where no cultivation may be given following planting. All of the southern pines are planted when 1 year old.

Hardwood seedlings may very easily be grown for planting. The seed may be collected locally or bought. They should be sown in prepared beds in much the same manner as a vegetable crop, and the young trees will require no more attention than such a crop. Coniferous seedlings or transplants require more attention for successful production, and it will usually be best to purchase such stock from a reputable nurseryman or from the State nursery. Most State forestry departments maintain nurseries that grow quantities of small pines

and spruces and some hardwoods to be sold at nominal prices for planting within the State. If purchased from a nurseryman, hardwood stock will cost from $2 to $10 per thousand trees and conifers from $2 to $12. A list of State and other nurseries which handle small trees or seed suitable for forest planting may be secured from the Forest Service, Washington, D. C.

GROWTH RATES OF DIFFERENT SPECIES OF TREES

The rate of growth of different trees varies widely. Some species are inherently more rapid growers than others; for example, the red oak, silver maple, white pine, and slash pine grow faster than the white oak group, sugar maple, red pine, and longleaf pine. Many kinds, including the ashes, American elm, and black walnut, are intermediate in rate of growth (fig. 10).

F—249059

FIGURE 10.—Thousands of farmers could easily have hundreds of black walnut trees growing in unused corners in their fields and along fence rows and streams. Black walnut trees are readily started by planting the nuts or 1-year-old seedlings. There is no easier way to increase the sale value of the farm and the yearly farm income. Early prunings would have increased the sale value of these trees.

Growth is also affected by the kind of situation or site, which is determined largely by the amount of plant food and moisture in the soil and its mechanical condition, as well as the elevation and slope of the surface. The density of the stand of trees influences the amount of sunlight and soil moisture and plant food each tree finds available.

The information in table 3 is based upon a large number of observations and measurements and should prove helpful in giving an approximate idea of the sizes of specified kinds of trees growing in different regions at ages 20, 30, 40, 50, 60, 80, and 100 years. The tabulation should not be regarded in any sense as exact or rigid, but rather as indicative of about the size and, therefore, the rate of growth of the different species under the specified conditions.

TABLE 3.—*Average growth of various species in different regions*

Species	Region	Growth and height at age of—													
		20 years		30 years		40 years		50 years		60 years		80 years		100 years	
		Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height
		Inches	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*
Aspen	Maine	2.4- 5.3	17-40	3.6- 8	28-55	4.7-10.4	39-66	5.8-12.7	50-75	7.0-14.8	57-81	9.3-19.2	64-87	11.7-23.3	66-89
Northern white cedar.	Minnesota	.7	4.7- 8	1.2	5.7-11	1.6	13	2.1	15	2.8	18	4.2	25	6.2	32
Ash, white	New York (good soil)	4.5- 8.2	34-52	7.1-12.2	47-67	9.4-15.3	57-75	11.2-17.7	65-79	13.1-19.6	71-81	16.5-22.8	81-83		
Do	Indiana (fair to poor upland).	1.6- 2.5	17-34	2.5- 4.1	26-45	3.5- 5.9	34-54	4.6- 8.2	41-62	6.0-10.9	47-68	10.3-18.4	57-78		
Ash, green	South Carolina (bottom land).	4.9- 9.4	41-57	7.1-12.8	52-69	9.1-15.7	62-79	11.0-18.5	70-87	12.9-21.1	78-95	16.4-25.9	90-107	19.7-30.5	100-117
Do	Arkansas (bottom land)	4.9- 7.8	31-(?)	7.4-11.4	45-(?)	9.7-14.6	57-(?)	11.7-17.4	67-(?)	13.5-19.9	76-(?)	17.0-24.2	92-(?)	20.1-28.1	105-(?)
Basswood	Michigan and Wisconsin	2.2- 3.3	23-32	3.6- 5.1	34-44	5.0- 6.9	43-54	6.5- 8.8	52-63	7.9-10.7	59-70	10.9-14.3	71-80	13.8-17.6	78-85
Beech	Michigan	.7- 1.3	13-19	1.5- 2.3	21-28	2.3- 3.3	28-35	3.0- 4.4	33-42	3.8- 5.4	39-48	5.4- 7.5	48-59	7.1- 9.6	57-68
Do	New York	1.0- (?)	10-16	1.5- (?)	14-23	2.0- (?)	18-30	2.5- (?)	22-36	3.1- (?)	26-41	4.6- (?)	33-52	6.4- (?)	41-61
Birch, yellow	Michigan and Wisconsin	1.1- 2.1	20-30	1.7- 3.3	26-39	2.3- 4.6	31-48	3.0- 5.8	37-54	3.8- 7.1	43-60	5.6- 9.8	53-68	7.7-12.5	62-73
Do	New York	1.8- (?)	14-22	2.6- (?)	19-31	3.5- (?)	24-40	4.5- (?)	29-47	5.4- (?)	33-53	7.4- (?)	39-64	9.4- (?)	46-74
Cedar, red	Alabama (open stand)	3.9	19.6	6.9	27.1	9.3		11.2		12.8		15.6			
Do	Alabama (forest-grown)	1.3	13.0	2.7	23.2	4.4	33.4	6.5		8.9		13.9			
Do	New York (forest-grown)	1.9		2.8		3.6		4.2		4.8					
Chestnut	Maryland (sprouts)	6.8	42	9.3	57	11.4	69	13.4	77	15.1	83	18.0	90	19.8	93
Do	Maryland (from seed)	3.4	17	6.0	33	8.7	52	11.2	64	13.4	73	17.2	84	20.1	91
Do	East Tennessee (from seed).		36-55		46-71		52-84		57-92		61-98		66-107		
Do	East Tennessee (cove type).	3.1		5.6		8.2		11.1		13.7		18.4		21.7	
Do	East Tennessee (slope type).	2.5		4.8		7.2		9.4		11.4		14.5		16.9	
Do	Connecticut	3.4		6.4		9.5		12.6		15.6		21.7		27.8	
Do	West Virginia (slope type).	2.4		4.3		6.4		8.4		10.4		14.4		18.2	
Do	New York	4.9		7.2		9.4		11.4		12.9					
Cottonwood	Mississippi Valley	12.3	97	17.4	115	22.0	127	26.5	136						
Do	South Carolina	12.6		17.4		21.4		25.1		28.2		33.5		37.6	
Baldcypress	Louisiana	5.2- 8.1	31-45	8.1-12.2	43-61	10.8-15.9	54-75	13.3-19.2	65-86	15.8-22.2	74-97	21.3- (?)	92-(?)		
Do	Maryland	3.5-10.0	22-44	6.2-14.2	33-58	8.7-17.6	46-71	11.1-20.5	60-82	13.3-23.2	72-91	17.3-28.6	88-106	21.3-33.3	101-119
Elm, white	Michigan and Wisconsin	.9- 2.8	21	1.7- 4.3	28	2.5- 5.7	34	3.3- 7.0	40	4.1- 8.2	45	5.7-10.4	53	7.3-12.6	61
Do	New York	3.6- 5.9	24-39	5.2- 8.4	31-50	6.6-10.6	37-57	7.9-12.5	41-62	9.2-14.2	45-66				
Fir, balsam	do	1.0- 1.3	14-22	1.8- 2.6	19-34	2.8- 4.0	27-45	3.8- 5.4	32-54	4.9- 6.5	36-61	6.5- 8.2	43-69	7.6- 9.5	48-73
Do	Maine	1.2	14-22	2.7	25-42	4.1	36-55	5.5	45-63	6.7	52-69	8.9	64-78	10.7	71-83

Gum, red	South Carolina[1]	7.9		11.2		14.2		16.8		19.2		23.4		26.9	
Do	Missouri	3.8		6.3		9.2		12.2		15.1		20.9		25.8	
Hemlock	Michigan	.7–2.0	8–18	1.3–3.9	12–21	2.1–5.7	16–42	2.9–7.6	20–53	3.8–9.4	25–62	5.7–12.8	35–76	7.8–16.1	44–85
Do	Southern Appalachians	.2–4.0	(?)–29	.9–6.7	9–41	1.3–9.0	11–53	1.9–11.2	14–63	2.4–13.1	17–71	3.6–16.9	24–86	4.9–20.6	31–98
Do	New York	.4–1.5	7–17	.9–2.9	10–28	1.4–4.4	13–39	1.9–5.9	16–49	2.5–7.4	20–58	4.0–10.5	28–73	5.5–13.8	36–84
Hickory	New York	3.6		5.4		7.1		8.6		10.0					
Mockernut	Ohio Valley	2.6		4.3		6.0		7.7		9.3		12.5		15.7	
Pignut	do	1.8		3.1		4.4		5.7		7.2		10.0		12.9	
Shagbark	do	1.7		2.9		4.1		5.3		6.5		9.0		11.6	
Pignut	Northern Kentucky and southern Indiana (fair to good soil second growth).	2.0	19	3.2	32	4.4	42	5.5	51	6.8	58	10.0	69		
Shagbark		2.8	18	4.0	32	5.4	43	6.8	51	8.0	58	10.5	70		
Bitternut		4.0	24	6.0	40	7.6	52	9.2	62	11.4	69				
Pignut	Northern Kentucky and southern Indiana (coppice; red clay soil).	3.8	31	5.5	43	7.0	52	8.5	59						
Shagbark		4.4	26	6.3	38	7.4	46	8.6	54						
Locust, black	Kentucky (close stand)	5.2		7.1		8.7									
Do	Kentucky (broken stand)	6.0		9.0		10.7									
Do	Kentucky (open stand)	9.3													
Maple, sugar or hard.	Michigan and Wisconsin	0.5–1.2	10–18	1.2–2.3	18–29	1.9–3.6	25–39	2.7–4.9	32–48	3.5–6.3	38–55	5.2–9.1	49–67	7.0–11.9	58–75
Do	New York	1.3	12–26	1.9	18–37	2.7	23–46	3.5	28–53	4.3	32–58	6.0	41–68	7.8	48–76
Oak, black	Tennessee (ridge)	4.0	29	6.8	40	9.5	51	11.3	61	12.4	70	14.2	83		
Do	Tennessee (cove and slope).	3.8		6.6		9.3		11.5		13.0		14.7			
Do	Kentucky (upland and bottom).	4.4		6.9		9.4		11.3		12.6		13.8		14.4	
Do	Southern Appalachians (sprouts):														
	Ridge	4.9	38.3	6.1	47.4										
	Slope	5.4	48.0	7.1	59.9										
Oak, black and scarlet.	Missouri (seeding)	2.6		4.4		6.2									
Do	New York (seedling)	2.2		3.8		5.3		6.7		7.7					
Do	New York (sprouts)	3.4		4.9		6.2		7.2		8.2					
Oak, chestnut	Tennessee (ridge)	0.7–0.9	29	1.6–1.9	40	2.5–2.9	47	3.4–4.0	53	4.3–5.1	58	6.1–7.4	63	7.9–9.8	
Do	Tennessee (cove)	1.7		3.7		5.6		7.3		8.9		11.6		13.9	
Do	Tennessee (slope)	1.2		2.4		3.4		4.3		5.4		7.7		10.0	
Do	Kentucky (ridge)	.7		1.6		2.5		3.4		4.3		6.1		7.9	
Do	New York (sprouts)	3.9		5.3		6.6		7.6		8.4					
Oak, red	North Carolina (slope)	1.5		2.8		4.4		5.9		7.5		11.3		15.3	
Do	Tennessee (cove and slope).	3.6	32	6.9	46	10.3	60	12.7	72	14.1	80	15.5			
Do	Kentucky (upland and bottom).	5.0		7.6		10.3		12.4		14.1					
Do	New York (sprouts)	4.1		6.1		8.0									
Oak, swamp white	New York (seedling)	2.7		4.4		5.9		7.1		8.3		10.2			
Do	New York (sprouts)	4.5		6.2		7.6		9.0		10.3					
Oak, white	Missouri	1.1		2.2		3.2		4.2		5.2		7.2		9.1	
Do	West Virginia (second growth)	3.1		4.4		5.4		6.3		7.2		8.6		10.0	

[1] Diameter on stump.

TABLE 3.—*Average growth of various species in different regions*—Continued

Species	Region	Growth and height at age of—													
		20 years		30 years		40 years		50 years		60 years		80 years		100 years	
		Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height	Diameter at height of 4½ feet	Height
		Inches	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*
Oak, white	New York (seedling)	2.2		4.1		5.7		7.1		8.2					
Do	New York (sprouts)	3.9		5.4		6.6		7.6		8.4					
Do	Kentucky (upland and bottom).	3.6		5.6		7.3		8.7		9.8		11.2		12.2	
Do	Kentucky (slope)	1.1		2.2		3.2		4.2		5.3		7.4		9.7	
Do	Tennessee (slope)	0.7		1.7		2.6		3.4		4.3		6.3		8.1	
Do	Tennessee (cove)	.9		2.0		3.0		4.1		5.1		7.1		9.1	
Do	Tenn. (second growth):														
	Cove and slope	3.3	25	5.9	38	8.3	51	10.3	63	11.7	71	13.3	77		
	Ridge	3.4	22	5.7	32	8.0	43	10.0	53	11.5	63	13.4	75		
Do	Southern Appalachians (sprouts):														
	Ridge	3.9	33.2	4.4	40.8										
	Slope	4.2	31.8	5.1	37.8										
Pine, jack	Minnesota (poor, sandy soil).	3.3–3.9		4.8–5.9		6.0–7.4		7.0–8.7		7.8–9.9		9.3–11.8			
Do	Minnesota (good, sandy loam).	4.4–5.5		6.2–7.9		7.5–9.4		8.5–10.8							
Pine, loblolly	South Carolina (old field)	6.1	38	10.0	59	13.3	75	15.9	86	18.1	94	21.5	104	24.5	111
Do	South Carolina (thicket)	4.0		7.4		10.5		13.0		14.9		17.7		20.0	
Do	Arkansas (thicket)	3.1		5.0		6.9		8.8		10.7		14.1		17.2	
Do	Eastern Texas: [2]														
	Pure stand on wet prairie.	6.7		8.8											
	Pure stand on light, fairly well-drained soil.	7.6		12.8		16.9		20.0		22.3					
	Mixed with hardwoods, poorly drained soil.	2.2		3.8		5.6		7.8		9.8		13.9		17.4	
	Mixed with hardwoods, well-drained, fertile soil.	6.1		9.5		12.4		15.0		17.2					
Do	Maryland	5.0–6.8	33–55	6.4–9.1	46–69	7.7–11.0	54–78	8.8–12.7	60–87						
Pine, longleaf	Alabama	1.4	10	2.8	22	4.5	33	6.2	38	7.9	49	11.2	64	14.0	76
Do	South Carolina	1.2–2.2		3.0–3.9		4.9–5.5		6.7–7.1		8.5–8.6		11.3–12.4		13.9–15.5	

Do	Texas	1.7	24	3.3	33	5.0	50	6.6	64	8.2	71	10.8	88	13.1	93
Do	Texas (second growth)	1.5–2.8		3.1– 5.8		4.9– 8.4		6.8–10.4		8.6–11.6		11.5–13.7		13.9–15.2	
Pine, red or Norway	Wisconsin	2.8–5.4	35–56	5.7–10.3	58–78	8.0–13.8	70–86	9.9–16.6	77–91	11.7–18.8	82–94	14.6–21.9	88–98	16.9–24.2	91–101
Do	Wisconsin (ridge)	2.7		5.2		7.5		9.3		11.0		13.7		15.9	
Do	Wisconsin (ravine)	3.3		5.8		8.2		10.3		12.1		15.3		17.6	
Do	Minnesota	2.8– 6.8	21–49	4.9–10.1	35–68	6.6–12.6	47–78	8.2–14.6	58–84	9.6–16.4	66–88	12.0–19.2	76–92	13.9–21.3	82–94
Do	Minnesota (mixture with jack pine).	1.7– 2.4		3.4– 4.2		4.8– 5.7		6.0		6.9					
Pine, scrub	Maryland	4.8– 6.8	33	6.5– 8.6	46	7.8–10.1	55	9.0–11.4	63	10.1–12.8					
Pine, shortleaf	Arkansas	5.7– 7.2	45–51	8.1– 9.9	54–59	10.1–12.0	60–64	11.7–13.6	64–68	12.9–15.1	66–71	15.0–17.5	71–76	16.6–19.4	74–81
Do	Missouri	1.6		3.4		5.1		6.7		8.2		10.7		12.7	
Do	North Carolina (second growth).	6.3–11.6	50–69	8.4–14.5	61–73	9.9–16.5	65–75	11.0–17.6	68–76	11.7–13.4	69–77	13.0–19.4	71–78		
Pine, white	New York	7.0– 7.4	26–27	10.2–11.2	40–42	11.8–13.6	52–55	12.8–15.5	60–65						
Do	New Hampshire	2.3– 4.0	14.5–24.5	3.9– 6.4	28.5–44	5.5– 8.6	43–61	7.0–10.8	54–75	8.6–12.8	64–86	11.7–16.5	78–102	14.5–19.8	87–113
Do	Minnesota	2.8		5.3		7.6		9.2		10.7		13.0		14.8	
Do	North Carolina (slope)	2.4		4.7		6.9		9.1		11.2		15.0		18.0	
Do	Tennessee (slope)	2.2		4.4		6.4		8.5		10.7		14.5		17.7	
Do	Tennessee (cove)	1.9		5.6		8.5		11.3		13.9		18.6		22.1	
Poplar, yellow	Tennessee	4.6– 5.7	40	7.7– 8.5	61	10.5–11.1	78	12.8–13.7	87	14.7–16.1	94				
Do	Tennessee (cove)	3.0– 3.4		5.0– 5.4		6.9– 7.3		8.7– 8.9		10.4		13.4–13.8		16.3–17.0	
Do	North Carolina (cove)	4.6		7.7		10.5		12.8		14.7		17.3		19.5	
Do	Virginia (quality 1—seedlings).	6.5	50	9.7	64	12.6	74	15.2	83	17.3					
Do	Virginia (quality 2—seedlings).	4.6	36	7.4	50	10.2	64	13.0	78	15.8		20.6		24.6	
Do	Virginia (sprouts)	7.4		10.2		12.7		15.0							
Spruce, red	Maine	.1		.6		.8		1.1		1.5		2.2		3.2	
Do	New York (spruce type)		5	.4	6	.7	8	1.0	9	1.3	11	2.0	14	2.9	18
Do	New York (spruce hardwood type).	.3	5	.7	7	1.1	8	1.5	10	2.0	12	3.2	18	4.4	27
Do	New York (balsam swamp type).		2		4	.4	5	1.1	7	1.8	9	3.1	16	4.2	26
Do	New Hampshire (second growth).	2.0	13–21	4.2	24–32	5.9	35–43	6.9	43–51	7.6	49–58	8.9	56–66		
Do	West Virginia	0.3– 1.2	6–11	0.9– 2.7	10–20	1.5– 4.3	13–30	2.1– 5.8	17–39	2.7– 7.2	20–47	4.1– 9.8	29–60	5.3–12.3	36–72
Tamarack	Minnesota (upland)	1.5– 1.7		2.5– 3.4		3.3– 4.9		4.2– 6.1		4.7– 7.0		5.9– 8.5		6.9–10.0	
Do	Minnesota (swamp)	1.6		2.9		4.0		5.0		5.8		6.9		7.8	
Pine, slash	Georgia (low upland)	7.5– 9.4	42–60	9.8–12.3	60–73	11.5–13.8	68–80	12.0–15.2	75–86						
Do	Florida (flat, wet)	5.4– 7.3	34–50	6.8– 9.9	48–65	8.0–11.9	55–72	9.0–12.5	65–76						

[2] Diameters inside bark on stumps 2 feet to 3.5 feet high.

U. S. GOVERNMENT PRINTING OFFICE: 1941